MEDICAL OFFICERS OF SCHOOLS ASSOCIATION

Poliomyelitis in Relation to the Spread of Infection by Schools.

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Poliomyelitis in Relation to the Spread of Infection by Schools.*

By FREDERICK E. BATTEN, M.D.,

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It is my intention to put before you to-day the evidence which has been accumulated during the past few years which goes to prove that poliomyelitis is sometimes spread from schools.

In this country we have not yet had the large epidemics, such as have occurred in Northern Europe and America, but during the past two years greater attention has been paid to the occurrence of the disease, and small epidemics have been noted in various portions of the country, notably in Carlisle, Maryport, Barrow-on-Furness, Bude, Plymouth, Falmouth, Dorset, Huntingdon, Westmorland, and other places. So far as England is concerned, there is no evidence as yet that the disease has been spread from a school, but this is not so with regard to Sweden, where the disease has been most widespread.

Before dealing with the school infection I would like to put before you what is now recognised as the clinical picture of poliomyelitis, and what is known of the virus which produces this disease.

The Clinical Aspect.

Poliomyelitis must be regarded as a disease which may affect any portion of the nervous system—commonly it affects the spinal cord and gives rise to a flaccid paralysis of one or more limbs, which is commonly recognised under the title "infantile paralysis," because it usually affects young children.

There is a type in which one or more of the cranial nerves may be affected, either alone or in association with paralysis of the limbs. Again, there is the type in which the paralysis starting in the lower limbs gradually ascends, affects the arms and eventually involves the respiratory centre. Then, again, there is a cerebral type of the disease, which gives rise to hemiplegia—acute mental defect, and to the symptoms of

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meningitis. It is this type that commonly passes unrecognised and is regarded as meningococcal meningitis.

The cerebellar type is characterised by marked ataxia, and another type by severe pains in the extremities—so-called "neuritic type." An abortive type also occurs in which the constitutional disturbance and paralysis is of transient nature, and such cases are only recognised when occurring in association with cases of more marked paralysis. Shortly it may be said there are the following types:—(1) The spinal type; (2) the bulbar or pontine type; (3) the ascending type; (4) the cerebral type; (5) the meningeal type; (6) the cerebellar type; (7) the neuritic type; (8) the abortive type.

The Virus of Poliomyelitis.

The history of the discovery of the virus of poliomyelitis is most interesting, but I can to-day only put before you a summary of our knowledge of this virus.

In 1909 Landsteiner and Popper obtained the spinal cord of a boy who died 24 hours after the onset of acute poliomyelitis, and injected an emulsion of this cord into various animals, among which were two monkeys. The monkeys alone of all the animals injected became paralysed, and after death showed the same changes in the spinal cord as are met with in the human subject.

Flexner, Lewis and Levaditi showed that it was possible to transmit the disease through an indefinite series of monkeys, and they showed that in whatever way the virus was introduced, by the brain, by the peritoneum, by intravascular injection, by intra-neural injections, or by subcutaneous injection, the disease became established in the brain and spinal cord.

No bacteria could be found in film preparation, or in cultures made from any of the animals infected. It was found that the virus would pass the Berkefeld or Chamberland filter, and that it would withstand the action of glycerine for many months. These two features bring the virus into close relation with that of rabies and vaccinia.

The virus will not grow on any of the ordinary media—it has not yet been stained, and has not been seen under the highest power of the microscope.

The virus of poliomyelitis can be shown to be present in the mucous membrane of the nose and in the salivary glands of an infected monkey. It has been shown that the virus may remain in an active state in the mucous membrane of a monkey for many months.

It is a striking fact that monkeys living in closest contact with monkeys suffering from the disease have never been known to contract the disease.

Shortly it may be said that the virus of poliomyelitis is a living organism, that it will pass the finest filter, that it will withstand the action of glycerine, that it cannot be cultivated on any of the ordinary media, that it cannot be seen under the highest power of the microscope, and that monkeys alone among the lower animals are susceptible to the virus.

The exact period of incubation is uncertain, but in 65 out of 81 monkeys infected it was under 12 days. The clinical evidence would seem to indicate that the incubation period is less than six days.

The contagion is probably carried by the nasal secretion, for it is possible to infect a monkey from the nasal mucous membrane of another monkey who has had the disease. The saliva has not been proved to carry the virus.

There are numerous instances of the disease being transmitted from person to person—there are numerous instances of two or more members of a family being affected—there are several instances in which the disease has been carried from one child to another child by persons not themselves suffering with the disease.

The infectivity of the disease is not great, being far less than scarlet fever or diphtheria, as the following table shows:

Of persons known to have been exposed to diphtheria, scarlet fever, and poliomyelitis the percentages contracting the disease were as follows:—

Scarlet Fever, 22 per cent.
Diphtheria, 17 per cent.
Poliomyelitis, 6 per cent.

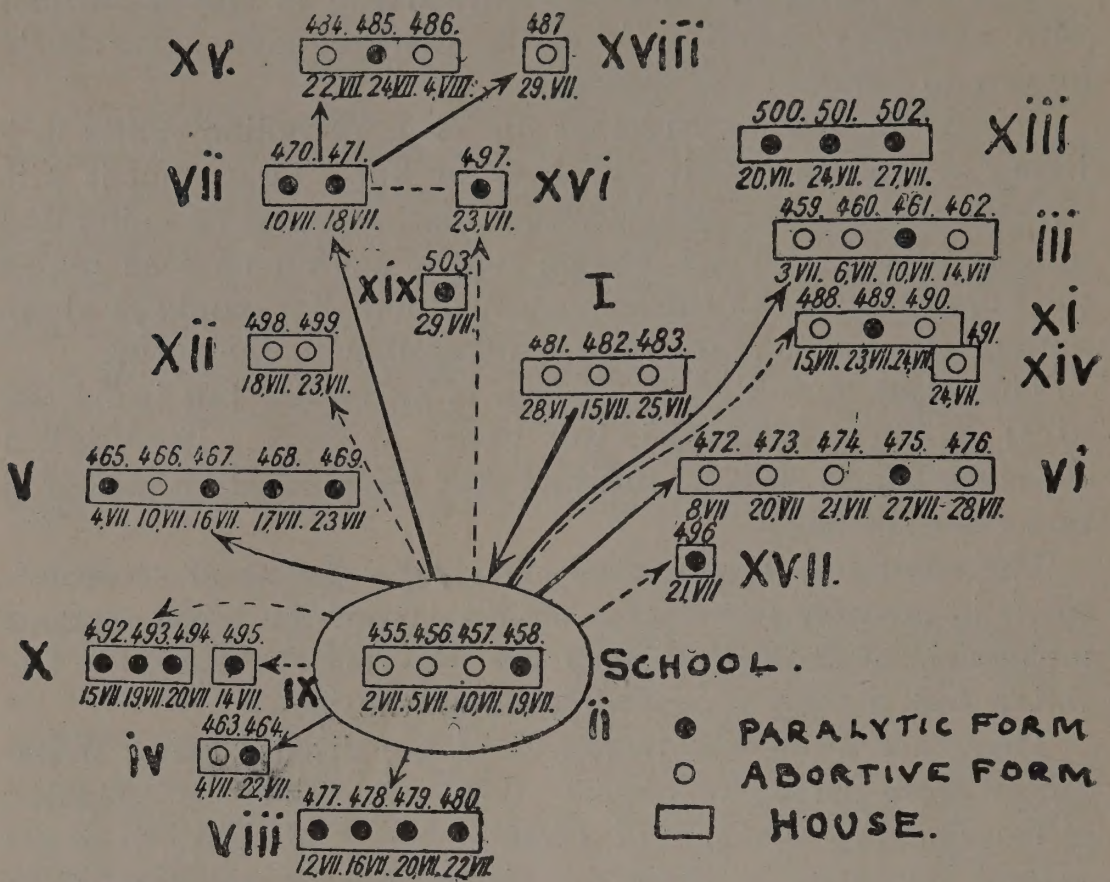
School Infection.

Having thus briefly put before you the clinical features of the disease, and what is known of the virus and its transmissibility, I will now ask you to consider the evidence that is brought forward with regard to the spread of infection by schools.

Wickman in the Swedish epidemic has clearly shown that the disease tends to travel along the railways and great thoroughfares, and he brings forward evidence that the disease is spread by schools. He cites four instances, the Trästena, the Gärdsby, the Sirko, and the Tingsryd epidemics.

The Trästena is the largest epidemic and the most carefully worked out as regards details, and the following are the facts as regards this epidemic.

FIG. 1.—TRASTENA SCHOOL EPIDEMIC (WICKMAN).



Inhabitants=500
Persons affected=49 Abortive cases, 23. Paralytic cases, 26. Deaths, 11
Number of houses in village=102
Number of houses infected=19
Continuous lines=direct infection
Interrupted lines=indirect infection
Large Roman figures=houses in order of infection
Number above houses=case numbers, the details of these cases can be found on reference to the table which follows
Figures below houses=day and month of infection.

Trästena is a small community of 500 inhabitants. The first case of poliomyelitis occurred in February and March in the little village of Sandbächen, three kilometres from the town of Marienstad, ten kilometres from Trästena. Three children were attacked in the same family on February 14th, and March 4th and 6th. One of these died. The others lived and were paralysed in the lower extremities. For three months no further case occurred in this region.

On May 31st and June 1st in the town of Marienstad two children were attacked in the same house; both had paralysis of the upper and lower extremities. On June 28th the first case occurred in Trästena in an isolated house. In rapid succession 49 inhabitants were taken ill, the majority being children.

In the 102 houses of Trästena there lived 132 families, and 19 houses were affected. The cases were divided as follows:

There was 1 case in 6 houses,
2 cases in 3 houses,
3 cases in 5 houses,
4 cases in 3 houses,
5 cases in 2 houses.

Of the six houses with single cases two had no children; the other four houses had one, two, three, and four children respectively, who were not affected. Among these 49 cases 26 were paralysed. Of the cases with paralysis 11 died, giving a mortality of 42.3 per cent. Ten per cent. of the inhabitants were affected.

By comparing the chart, Fig. I., and the table of cases, it is easy to follow the course of the epidemic.

No. 481 in house No. I. attended school on June 28th, and was taken ill on that day. Seven other children in houses II., III., IV., V., VI., VII., VIII., attended school and were taken ill on July 2nd, 3rd, 4th, 8th, 10th, and 12th respectively; and they, being children of school age, were the first persons to be affected in these houses. These are marked on the chart with a direct line. In one family (house VIII.) in which four members (477, 478, 479, 480) were attacked, 477 was the only one who attended school.

In five houses, Nos. IX., X., XI., XVI., and XVII., the affected members taken ill on July 14th, 15th, 21st, and 23rd respectively had brothers and sisters who attended school (these are marked on the chart with an interrupted line). In one house, No. XII., two children were taken ill on July 18th and 23rd (Nos. 489 and 499), these neither went to school nor had brothers or sisters who did. These two children lived in the same one-storied house as a school child who, however, was not affected. Of the remaining cases, No. 484 in House XV. visited No. 471 on July 19th, and was taken ill on July 22nd.

No. 487 in House XVIII. worked in House VII., and the father of 497, House XVI., also worked in this house, but 497 also had a brother who attended school.

Three houses yet remain to be accounted for, viz.: Houses XIII., XIV., and XIX. House XIV. is a neighbouring house to House XI., and there was frequent communication between these two houses.

In Houses XIII. and XIX. no definite line of infection could be traced. These cases, however, occurred late in the epidemic, and there were many opportunities of infection. In those houses in which the infection was direct the first case occurred between June 28th and July 12th, whilst in the houses in which it was indirect the cases occurred from July 12th to 23rd. The school was shut on July 15th.

There seems no doubt that the virus was transmitted from person to person, and that it was often caused by an intermediate person who was not suffering from the disease.

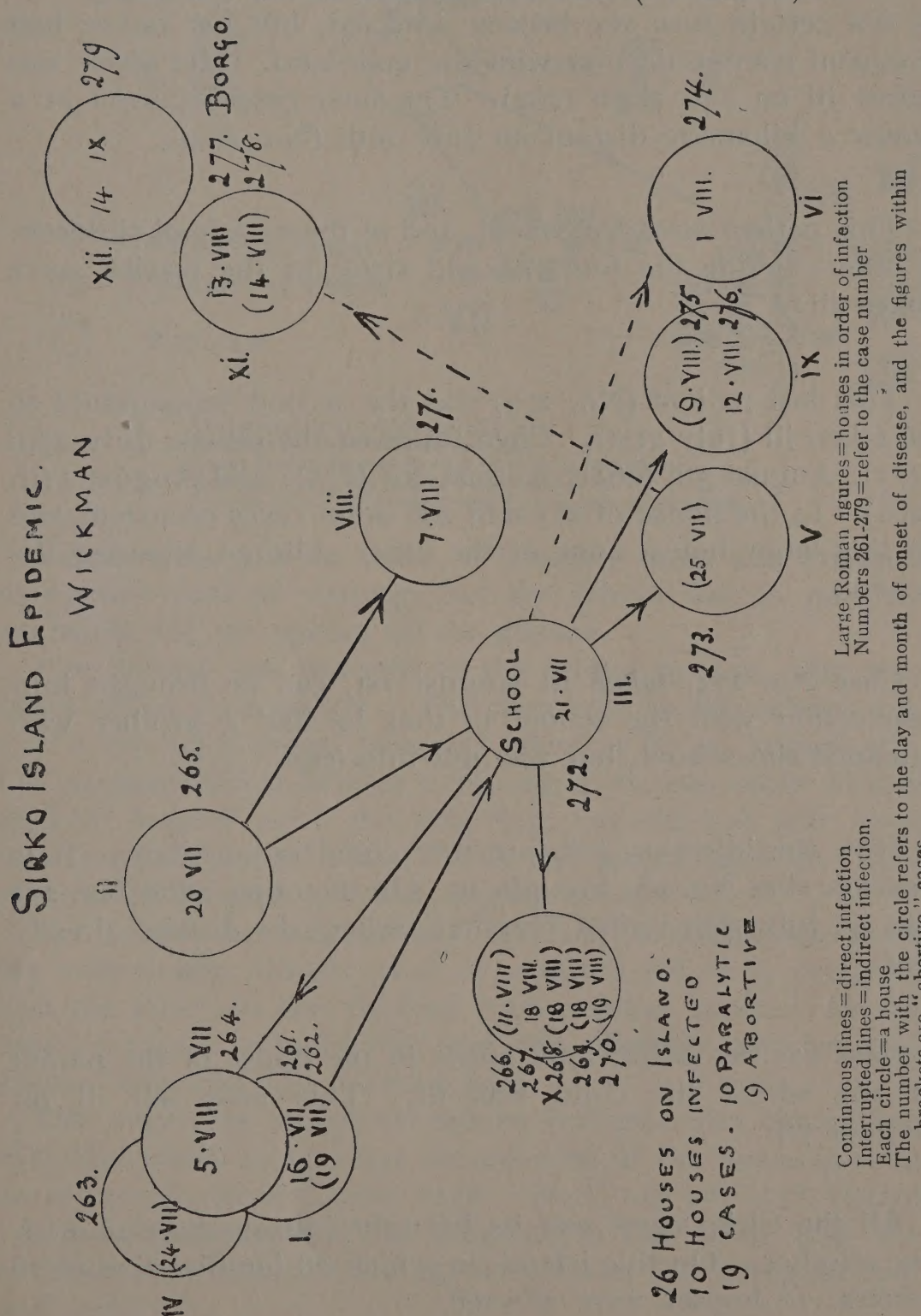
It is quite clear that this epidemic was not carried by water or by milk.

Table of Trästena Cases.

Houses	Ages	Forms of Disease.	Date of onset
House I.			
481 M ...	11 ...	Abortive	June 28th
482 F ...	17 ...	„	July 15th
483 M ...	14 ...	„	„ 25th
House II.			
455 F ...	11 ...	„	„ 2nd
456 F ...	10 ...	„	„ 5th
457 F ...	14 ...	„	„ 10th
458 F ...	18 ...	Meningitis, facial paralysis	„ 19th
House III.			
459 M ...	12 ...	Abortive	„ 3rd
460 M ...	8 ...	„	„ 6th
461 F ...	14 ...	Ocular paralysis and right arm and back muscles	„ 10th
462 M ...	5 ...	Abortive	„ 14th
House IV.			
463 F ...	11 ...	Abortive	„ 4th
464 M ...	18 ...	Left leg	„ 22nd
House V.			
465 F ...	9 ...	Right leg	„ 4th
466 M ...	12 ...	Abortive	„ 10th
467 F ...	5 ...	Limbs, back and neck ...	„ 16th
468 M ...	7 ...	Multiple paralysis ...	„ 17th
469 F ...	17 ...	Ascending form. Death ..	„ 23rd
House VI.			
472 M ...	12 ...	Abortive	„ 8th
473 M ...	14 ...	„	„ 20th
474 M ...	15 ...	„	„ 21st
475 F ...	17 ...	Paralysis arms and legs, pains	„ 27th
467 F ...	21 ...	Abortive	„ 28th
House VII.			
470 M ...	10 ...	Limbs, back, abdomen ...	„ 10th
471 F ...	14 ...	Legs	„ 18th
House VIII.			
477 M ...	11 ...	Neck, limbs	„ 12th
478 M ...	11 ...	Meningitis, transient paralysis	„ 16th
479 M ...	17 ...	Ascending form. Death	„ 20th
480 M ...	19 ...	Ascending form. Death	„ 22nd
House IX.			
495 M ...	13 ..	Ascending form. Death	„ 14th
House X.			
492 F ...	1 ...	Ascending form. Death	„ 15th
493 M ...	7 ...	Right arm „ „	„ 19th
494 F ...	5 ...	Right lower limbs, pain	„ 20th
House XI.			
488 F ...	14 ...	Abortive	„ 15th
489 F ...	3 ...	scending form. Death	„ 23rd
490 F ...	8 ...	Abortive form	„ 24th
House XIV.			
491 F ...	32 ...	Abortive form	„ 24th
House XII.			
498 M ...	15 ...	„ „	„ 18th
499 F ..	12 ...	„ „	„ 23rd
House XIII.			
500 M ...	1 ...	Extensive, death	„ 20th
501 F ...	5 ...	Ascending, death	„ 24th
502 F ...	3 ...	Right arm	„ 27th

Houses	Ages	Forms of Disease	Date of onset
House XV.			
484 F ...	15 ...	Abortive	July 22nd
485 F ...	13 ...	Ascending form. Death	„ 24th
486 M ...	23 ...	Abortive	Aug. 4th
House XVI.			
497 M ...	9 ...	Bulbar paralysis	July 23rd
House XVII.			
496 M ...	4 ...	Death	„ 27th
House XVIII.			
487 M ...	19 ...	Meningitis	„ 29th
House XIX			
503 M ...	9 ...	Ascending form. Death	„ 29th

FIG. 2.—SIRKO ISLAND EPIDEMIC (WICKMAN).



The Sirko group of cases occurred in a small island of that name, and in the neighbouring island of Borgo. There were 19 cases, of which 10 were paralysed and 9 were abortive.

Sirko is an island 5 kilometres long and 1 to 2 kilometres broad, and is connected at both ends with the mainland by a bridge.

The first case occurred on July 16th, 1905 (No. 261). It is not certain how she became infected, but her father had frequent communication with the mainland. Her sister was taken ill on July 19th (262). The next case occurred at a house 1 kilometre distant on July 20th (No. 265).

This patient attended school, and of the 21 school children, 4 others beside the four-year-old sister of the teacher were taken ill.

This last patient (No. 272) was the second school-child to be taken ill (July 21st). Then followed the others, July 25th (273); August 5th (264); August 9th (275); and August 11th (266). In the house of 275 and 266 other cases occurred, and in this latter house none of the other children attended the school.

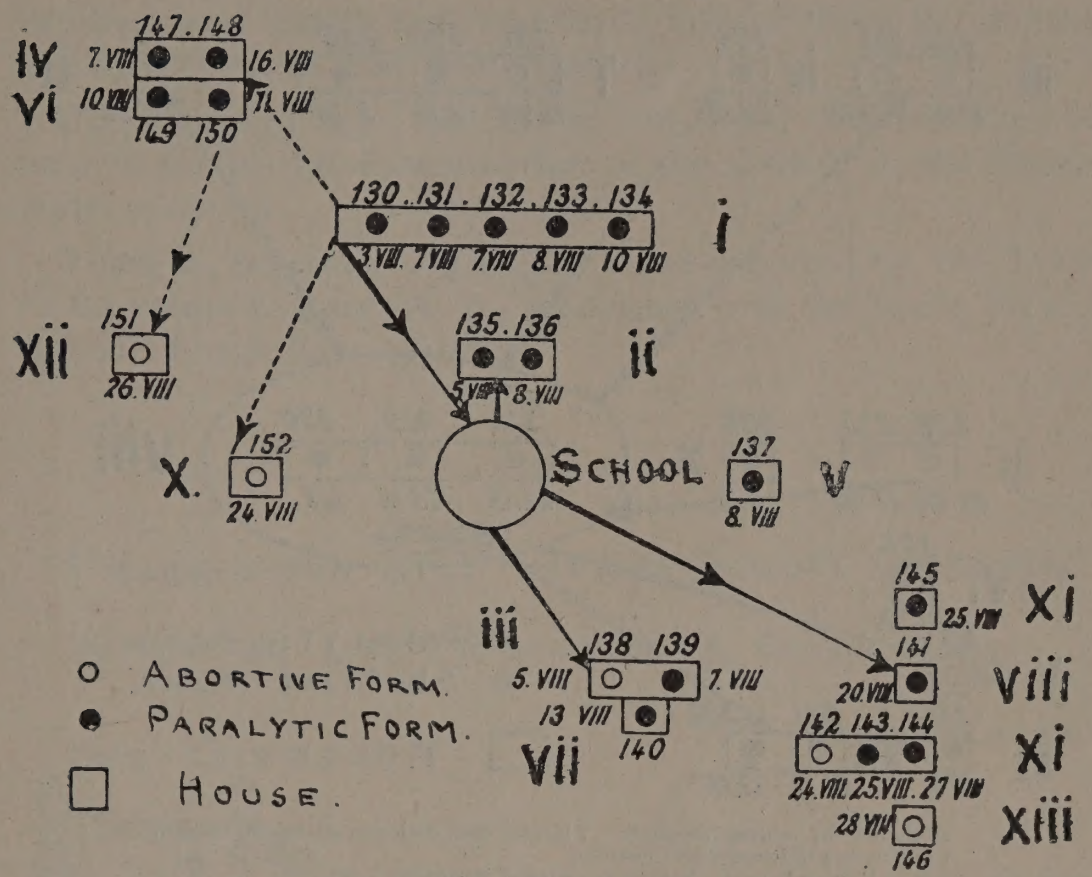
Case No. 274, taken ill August 1st, can be brought into connection with the school in that he had a brother who attended the school, but was not infected.

How the infection got into the school is uncertain. It is possible that No. 265 brought it. On the other hand No. 272 had on July 18th visited Hurshult, where the disease already was.

Case 271, an adult, took meals in the house of the parent of 265 whilst the child was ill. This man fell ill on August 7th.

All the Sirko cases can be brought into connection with one another. On this island, in which 28 families live in 26 houses, 10 houses were affected.

FIG. 3.—GÄRDSBY EPIDEMIC (WICKMAN).



Continuous lines=direct infection
Interrupted lines=indirect infection
Large Roman figures=houses in order of infection
Numbers above the houses=case number
Figures below the houses=day and month of infection

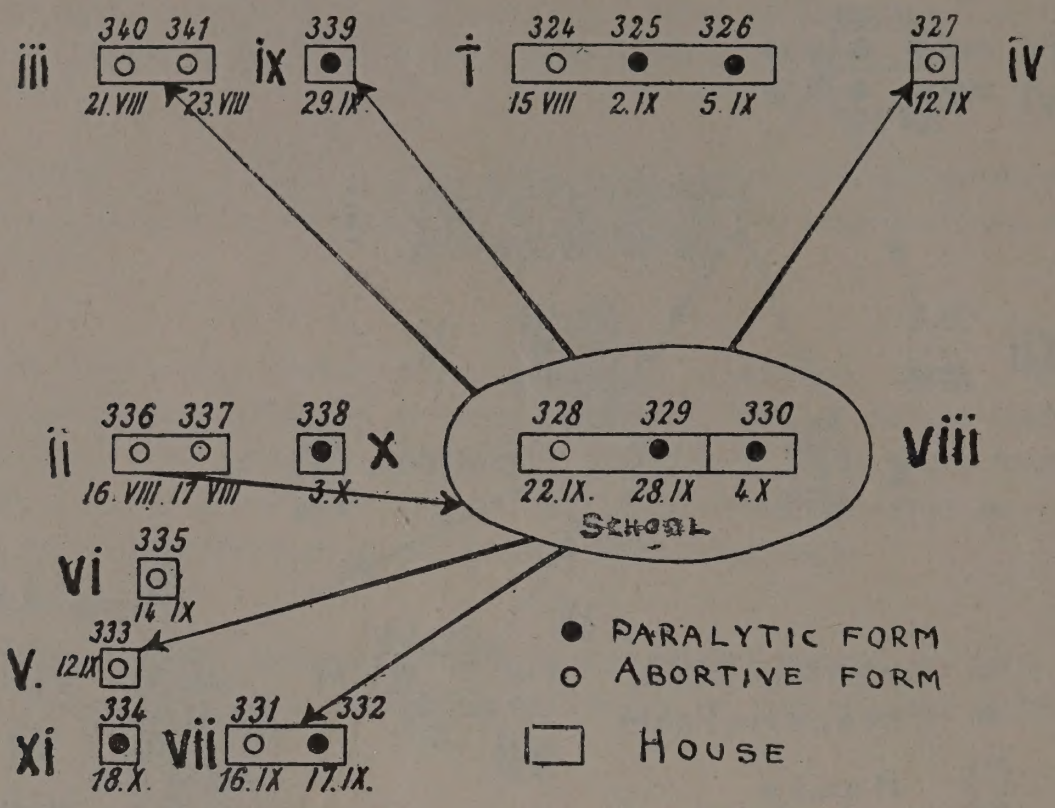
Between the various cases in Gärdsby there was evidence of a good deal of visiting, but the school was in part responsible for the spread of the disease.

The disease was brought to the school by 130, who was taken ill on August 3rd. The next case in the school was 138, a boy aged eight, who was taken in ill on August 5th. On August 7th his brother (139), aged 18, was taken ill and died on August 10th. So, too, Nos. 135 and 136, who lived near the school and played with the school children, were affected on August 5th and August 8th.

The school was attended by 141, 144, and 146, but since the school was already shut on August 7th it is probable that the infection was derived from another source. In the case of 144, a school-child, she was affected *after* her two sisters, who did not attend school.

The only case which cannot be brought into connection with the school is 137, but the position of the house is such as to render contact quite easy. Nos. 147 and 148 visited 130, and were taken ill on August 7th and 16th, and the children next door 149 and 150 were taken ill on August 10th and 11th.

FIG. 4.—THE TINGSRYD EPIDEMIC (WICKMAN).



18 Cases—11 houses affected. 7 houses had children attending school.
Continuous lines=direct infection
Large Roman figures=houses in order of infection
Numbers above the houses=case numbers
Figures below the houses=day and month of infection.

This epidemic affected 18 persons; 8 had the paralytic form of the disease and 10 the abortive form. Of the 18, 10 attended school, and one of these (No. 328) lived in the school house, as was also the case with his brother (329), who was later affected, and the son of the schoolmaster (330). Seven of the 11 houses affected had children attending school (Nos. II., III., IV., V., VII., VIII., IX.), and these children were taken ill on August 16th and 21st, and September 12th, 16th, 22nd, and 29th. There are six cases which cannot be brought into connection with the school.

The school was shut on September 19th, and only two of the actual school-children were affected after that date, viz.: No. 328 on September 22nd, and No. 339 on September 29th. (See Fig. IV.)

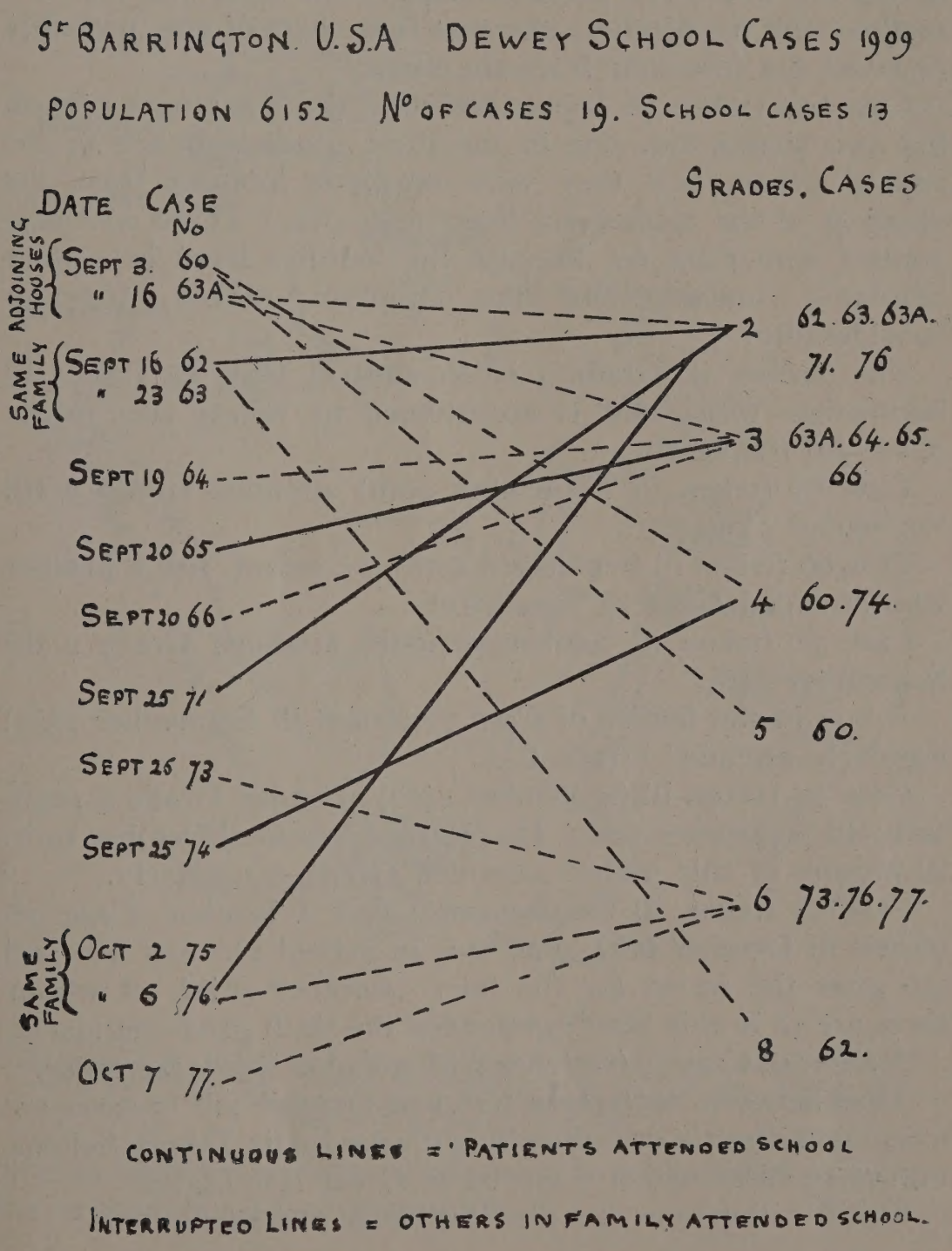
Lindner and Mally in the Stevr epidemic express the view that the school is a method of disseminating the disease, but bring forward no striking cases in support of this view. Potpeschnigg in the Steiermark epidemic gives the following instance: The child, M. P., aged seven, attending school, was taken ill with poliomvelitis on June 25th; two days later the child, A. S., aged six years, who sat next her at school and was her playfellow, was taken ill with follicular tonsillitis.

In the course of the week the mother of this child and five brothers and sisters had tonsillitis, and of these the mother and two children had poliomyelitis.

Potpeschnigg says that the school could *not* be shown to be a factor in the dissemination of the disease in the Steiermark epidemic.

There is, however, a group of cases reported by Dr. Jones in Berkshire County, N.Y., associated with the Justin Dewey School, Great Barrington.

FIG. 5.



The schools opened on September 7th, and the session continued until Friday, September 24th, when a recess was taken for a week, on account of the Great Barrington Fair. School work was resumed on Monday, October 4th.

Case 60 (taken ill on September 3rd) did not attend school, but a brother regularly attended the fifth grade, while a brother and sister attended the fourth grade regularly.

Case 62, an abortive case, taken ill on September 16th, attended school, grade 2, on September 7th and 8th. She was then out till October 18th. A sister attended the eighth grade regularly.

Case 63, a brother of the foregoing, became ill on September 23rd. These two children slept in the same bed with the mother, and the brother, who was four years of age, probably received his infection from the sister.

Case 63A (taken ill September 16th) did not attend school, but two sisters did, one in the third grade and one in the second grade, and they were regularly present from the opening of the session on September 7th. There was also contact with Case 60, because the families lived in closely adjoining houses, and the children played together considerably.

The teacher in Grade 3 is an aunt of Case 64 (taken ill September 19th), and is accustomed to seeing her niece (Case 46) frequently.

Case 65 (taken ill September 20th) attended Grade 3 till September 22nd.

Case 66 (taken ill September 20th), an infant, had a brother who attended Grade 3 regularly.

Case 71 (taken ill September 25th) attended Grade 2 till September 24th.

A boy in the family of Case 73 (taken ill September 25th) regularly attended Grade 6.

Case 74 (taken ill September 25th) attended Grade 4 regularly till September 14th. He returned to school October 19th. A brother of this patient attended Grade 2 regularly.

Case 75 (taken ill October 2nd) had a brother, Case 76 (taken ill October 6th), who was in school October 4th and 5th after the recess for the fair. Another child, of whom there are 12 in this family, attended the sixth grade regularly.

A sister of Case 77 (October 7th) attended Grade 6 regularly.

Thus between September 16th and October 7th 13 cases are associated directly or indirectly with the Justin Dewey School, out of 19 cases which occurred at Great Barrington.

Fig. V. illustrates the distribution of the cases.

An extremely interesting note of an epidemic which occurred in Westmorland in July, August, and September, 1911, has been furnished me by Dr. Henderson, Medical Officer of Health for the County of Westmorland. He says:—

The Westmorland epidemic started at Staveley about July 12th, 1911 (see Fig. 6). One of the cases at this place—a

FIG. 6.

Cumberland and Westmorland.—The X's indicate the cases of poliomyelitis which occurred in 1910 and 1911. Those in 1910 were investigated by Dr. Garrow. Those in the area wtthin the circle were investigated by Dr. Henderson (M.O.H., Westmorland), and occurred during the summer of 1911.

child of fourteen months—died, death being certified as being due to posterior basal meningitis.

At the end of August two cases were observed in the same house at a lone little farm at Underbarrow, and about the same time some cases occurred in Kendal.

On September 8th two cases occurred at Milnthorpe. One case was that of a child twelve months old who died, death being certified as being due to posterior basal meningitis. Then other cases occurred in the neighbourhood of Milnthorpe.

On September 14th two children—boys, aged nine and eleven years—living a mile apart at Crook, but *attending the same school,* were stricken with a severe type of the disease.

On September 28th a young woman, aged 21, living in comfortable circumstances, died after an illness of two days, the attack taking the form of an ascending myelitis, involving the respiratory centres.

In all there have been about forty cases, with eight deaths.

The geographical distribution of the cases forms, roughly, a belt along the south-western portion of the County of Westmorland, which belt embraces most of the main roads from the south to the lakes, and along which a heavy motor traffic passes.

Some very interesting facts emerge when one begins to investigate this question. For instance, whilst examining the school children at Warcop—a little village with a population of 600, lying in a deep pastoral solitude near the Eden Valley, mid-way between Appleby and Kirkby Stephen—I saw a boy, aged 13, greatly crippled as a result of an attack of poliomyelitis ten years ago. On inquiry at the child's house and elsewhere in the village I elicited the following history :—Forty-five years ago four cases of infantile paralysis occurred within a week. All were males, all recovered, and all were permanently crippled. All have resided in the village most of their lives since. Thirteen years ago three children were attacked. Ten years ago the above-mentioned boy passed through a typical and very severe attack of poliomyelitis. Six years ago a child aged two and a-half years had an attack of polioencephalitis which involved the facial muscles.

Dr. Henderson raises the question as to whether there is a carrier case in this village.

The cases occurring on September 14th in two schoolboys at Crook are of special interest in connection with the subject of this paper. Nothing can be deducted from the facts as recorded, but they suggest a line on which further

investigation should be pursued. It is interesting to note that nearly half the number of cases occurred in children within the school age.

Evidences Against the School Being a Factor in the Dissemination of Poliomyelitis.

Having placed before you the facts in evidence of the school being a source for the spread of infection, let us consider the case for the other side.

It is a striking fact that a large percentage of the cases occur before school ages; 75 per cent. of the cases occur before the child is four years old. Again, it is very rare for the disease to occur in an epidemic form in institutions. In the Massachusetts epidemic of 1909 in 45 institutions investigated, where 3,600 young children lived, only *one* child developed the disease, and there was no spread of the infection from this case.

In hospitals where cases of poliomyelitis are admitted into the general ward the disease has never been known to spread.

In the Massachusetts epidemic out of 150 cases of poliomyelitis carefully investigated, 35 attended school; 22 of these were at different schools: at three schools there were two cases; at one school three cases; and at one school four cases. It is clear that the schools in this epidemic could not be said to be a centre from which infection spread.

I have put before you certain facts which go to prove that the school is sometimes the means by which poliomyelitis is spread from child to child. I have also put before you facts that show that there is no tendency for the disease to spread when it occurs in an institution in which numerous children live. I do not think the evidence of the spread of infection by schools is strong, but it is important to bear in mind the possibility, and in the investigation of any epidemics that occur, and especially an epidemic in a small town or village, to consider carefully what influence the school may exercise in disseminating the disease. It may well be asked what precaution should be adopted in dealing with a case of poliomyelitis, or in children coming from a house in which poliomyelitis has recently occurred.

Considering that the incubation period is experimentally between eight and twelve days it would seem advisable to give all contacts a quarantine of fourteen days before returning to school.

The time when the infected may be considered free from infection is a most difficult question to answer. The organism,

as in diphtheria, may in certain cases remain in the mucous membrane for many months. In diphtheria it is possible to find the organism, in poliomyelitis it is not so, and, therefore, one has to fix an arbitrary period at which the patient may be thought to be free from infection. In many cases the paralysis is so severe that there is no chance of the patient returning to school for several months, but in the slighter cases recovery may be rapid, and the child is well at the end of fourteen days. I consider that an infected child should not return to school for at least a month after the onset of the illness, and only then if convalescence is complete and there is no discharge from the nose. It is known experimentally that urotropin tends to delay and prevent infection, and it should, therefore, be given to the infected person with a view to destroying the virus. It might well be used with the same object in view to prevent the infection of the contacts.

Conclusion.

In dealing with the spread of infection of poliomyelitis by schools I have placed before you the evidence which has been obtained on this subject. The evidence is not conclusive. In this country the spread of infection has never been traced to the school, but it must be remembered that most, if not all, the epidemics have been investigated at a considerable period after their onset. Many of the slighter cases are never recorded, and no attempt has been made to follow up and examine the cases with regard to their school attendance.

The notification of poliomyelitis which is at present in force should provide information from which it may be possible to trace the source and method of spread of the infection.

Whether poliomyelitis is or is not spread by school is a question which has yet to be answered, but it is important for medical officers of schools to recognise the possibility of such an occurrence, and this paper will not have failed in its object if it serves to call the attention of medical officers of schools to the possibility that the school may be a centre from which poliomyelitis may be spread.

References—

(1) Wickman. Heine, Medinische Krankheit, 1907.

(2) Lovett. Bulletin, Massachusetts States Board of Health.

Reference to other papers referred to will be found in

(3) Batten. *Epidemiology of Poliomyelitic Brains*, 1911, XXXIV., 45.

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